Imaging Reality and Abstraction

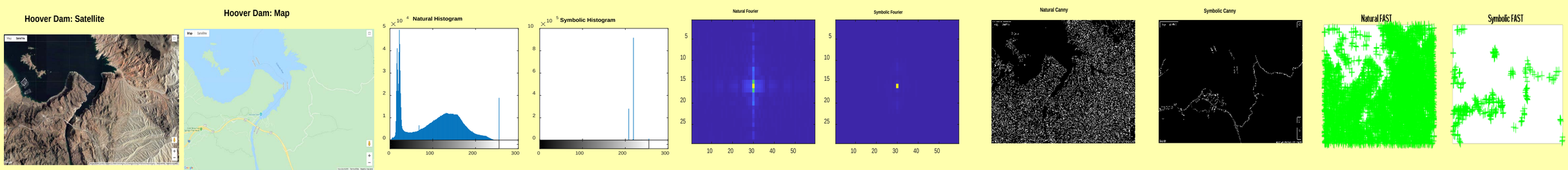
An Exploration of Natural and Symbolic Patterns

Alexandra Branzan Albu
Electrical and Computer Engineering,
University of Victoria, Victoria, BC, Canada
aalbu@uvic.ca,

George Nagy
Electrical, Computer, and Systems Engineering,
Rensselaer Polytechnic Institute, Troy, NY, USA
nagy@ecse.rpi.edu

Natural vs. Symbolic Image Processing and Pattern Recognition

Natural and symbolic image types, and their many sub-types, may require different processing methods in the pipeline from preprocessing to final interpretation. When the source of the image is known, its type can usually be readily ascertained. However, for truly automated, source-agnostic processing, the type must be assigned automatically. The natural and symbolic versions of the Hoover Dam scene below are easily distinguished by simple algorithms for the density histogram, 2-D frequency, Canny edges, and FAST features. However, further research is needed to develop broadly applicable method that can resolve even this simple dichotomy for all images. Parallel studies could be launched for *sound*, and perhaps even for *olfactory signals*.

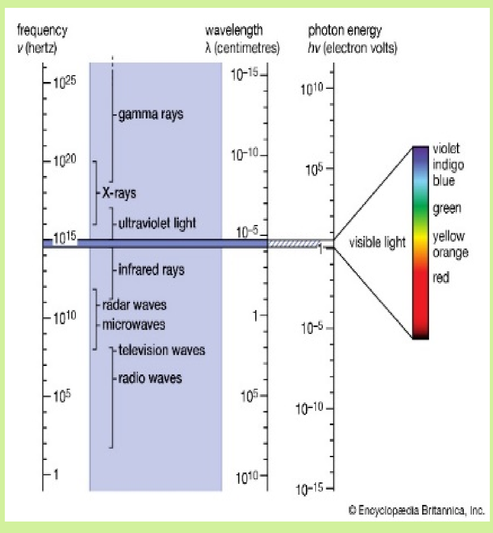


Natural images

Can be interpreted by many species
It is an evolutionary survival skill
Generated by *physical, chemical* and *biological* processes

Examples from a popular image date base:

Natural images span the entire electromagnetic spectrum, from nanometers for atomic lattices, to micrometers for biological cells, mm and meters for animals, plants and organs, and light years for astronomical observations.



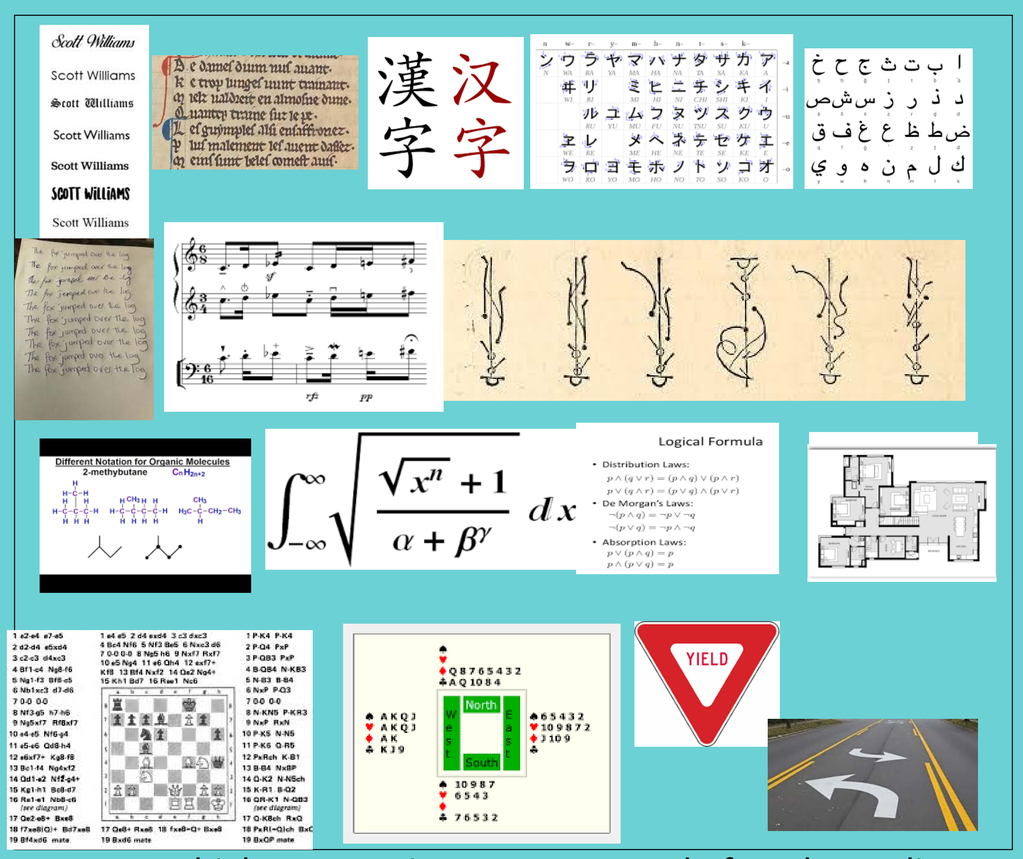
Cosmic-ray muography (muon tomography)
Atomic force and electron microscopy
Medical and industrial radiography (X-rays)
Industrial surface inspection, fluorography (UV)
Photography, microscopy, telescopy (visible light)
Night vision, thermography, FLIR, LIDAR (IR)
Weather, traffic and military RADAR (microwaves)
Radio-telescopy, MRI (radio frequency)
Medical and industrial ultrasound

Applications: Photo labeling, biometrics (face, fingerprint, iris), medical imaging (computed tomography (CT), magnetic resonance imaging (MRI), Doppler ultrasound, scintigraphy, single photon emission computed tomography (SPECT) and positron emission tomography (PET)), star maps, characterization of materials, remote sensing of earth resources. Current research addresses 2.5D, 3D and 4D, including video sequences with variable lighting, relative motion between multiple sensors and targets, and data from non-imaging sensors. Image processing and pattern recognition are morphing into computer vision.

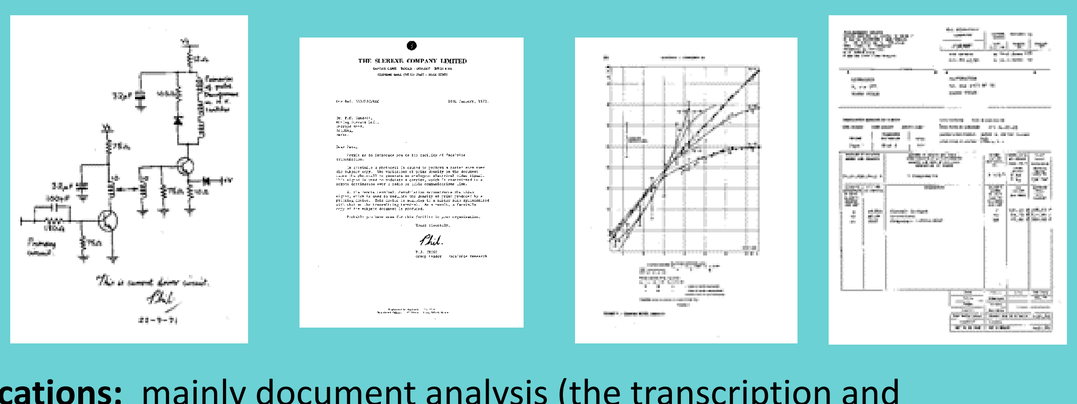
Symbolic images

Created and interpreted only by humans
Fundamental to civilization, culture and science
The study of signs, symbols and significance is called *Semiotics*

Examples of symbolic images for communicating abstractions:



Documents are high contrast images composed of strokes or line segments in the visible range, such as these test images for facsimile transmission:



Applications: mainly document analysis (the transcription and interpretation of books, magazines, newspapers, handwritten letters and notes, plans and diagrams, musical scores, tables, maps, charts, graphs). Because most documents of current importance are computer generated, many 20th C applications are disappearing. Computer-generated documents often cannot be associated with a single author or source. Current objectives include deep document understanding, search, summarization, translation, information extraction, table analysis, and sketch understanding. *Scene text analysis* addresses hybrid images.

The question raised in this white paper is whether a taxonomy of image *types* could narrow and systematize the choice of image processing and classification methods.